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Department of
Agriculture

Forest
Service

**Southwestern
Region**

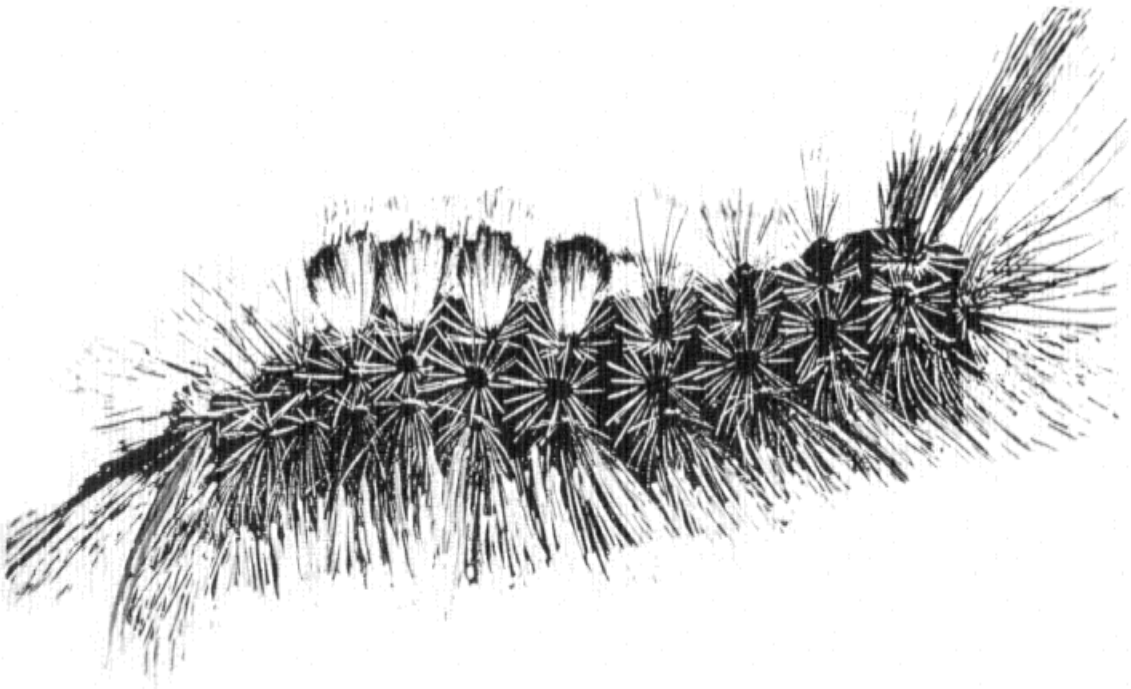
Forest Health

R3-FH-08-01

Santa Clara Canyon 2007 Douglas-fir Tussock Moth Suppression Project Using TM-Biocontrol-1 Virus, Santa Clara Pueblo, New Mexico

August 2008

Terrence J. Rogers and Debra Allen-Reid



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Introduction

In April 2007, Douglas-fir tussock moth (DFTM), *Orgyia pseudotsugata,* egg masses were discovered on the Santa Clara Pueblo in Santa Clara Canyon, New Mexico. This was the first time in 28 years that the tussock moth had been detected in the Jemez Mountains. Outbreaks of the DFTM in the Jemez Mountains had been suppressed in 1974, 1975, and 1976 using various formulations of the biological insecticide, *Bacillus thuringiensis* var. *kurstaki*, (Lessard and Holland, 1985). A sequential egg mass survey conducted on May 1, 2007 in Santa Clara Canyon revealed robust, abundant tussock moth egg masses. Left unchecked, the levels of infestation were expected to cause severe defoliation later that summer (Appendix A).

Results of the DFTM egg mass survey along with treatment options were provided to the Division of Forestry, Santa Clara Pueblo (Appendix B). Because the tussock moth infestation was located along Santa Clara Creek and several fishing ponds, treatment options were limited to microbial controls such as the nucleopolyhedrosis virus TM-BIOCONTROL-1, or the bacterium, *Bacillus thuringiensis* var. *kurstaki*. Based on the results of the egg mass survey, the Santa Clara Pueblo Tribal Council and its members chose to implement a suppression strategy using the virus, TM-BIOCONTROL-1. This option was chosen because it has minimal non-target effects and is host specific to tussock moth caterpillars.

The Tribe was particularly concerned about the status of their Douglas-fir since many acres of this species were lost in the Cerro Grande fire of 2000. Douglas-fir trees are of special cultural importance to the Pueblo of Santa Clara and several other surrounding Pueblos as well, where Douglas-fir boughs are commonly used for ceremonial purposes.

Because the timeframe for preparing an Environmental Assessment and meeting other NEPA compliance requirements would have exceeded the biological window for suppression of this generation of DFTM, the Santa Clara Tribal Council opted not to request federal funds for the project and instead decided to assume the cost of the project themselves. The Tribe thus engaged a full-service aerial applicator and assumed the cost of purchase and shipment of the liquid carrier required for virus application.

Under a "Participating Agreement between the USDA Forest Service, Southwestern Region and the Santa Clara Pueblo" (Appendix C), the Forest Service provided the Tribe with 1200 acre-equivalents of the TM-BIOCONTROL-1 virus and provided technical assistance for proper handling and application of the material.

Treatment Objectives

Host mortality from DFTM usually occurs following the second year of heavy defoliation. Because this outbreak was detected between the release and peak phases, that is, just before the first year of visible defoliation, the objective of this suppression project was to keep the treated population from surviving to reproductive maturity, thus preventing the second year of heavy defoliation. Natural population regulation mechanisms (parasites, predators, disease) often do not "catch up" with DFTM outbreaks until after the second year of heavy defoliation. By applying the virus prior to the first visible defoliation, we sought to prematurely initiate the population decline phase; that is, to cause a premature collapse of the population. By suppressing the population, we also hoped to prevent tussock moth spread to adjacent, uninfested stands.

Project Area

The project area is located in the upper portions of Santa Clara Canyon in the mixed conifer forest cover type. The Canyon, valued for its recreational opportunities, is a deep tree line-lined retreat with several mountain-ringed fishing ponds, camp sites, and picnic areas. Canyon wall elevations rise to over 10,000 feet. Initially, Tribal forestry wanted to spray all of the mixed conifer type in the Canyon, totaling approximately 10,000 acres. Later, based on GPS points on where the outbreak and host component began and ended, the proposed treatment area was decreased to 3000 acres. Because of limited funding, the treatment area was further reduced to 1,130 priority acres. Since there was no comparable infested site that could serve as an untreated control block, natural larval mortality from non-treatment related factors was impossible to measure.

Monitoring Egg Mass Hatch and Larval Dispersal

Degree-day accumulation (Appendix A) was used to monitor egg mass hatch, larval dispersal, and to establish an appropriate window for treatment. The relationship between accumulation of degree-days and insect-host phenology was used to predict timing of egg hatch, larval dispersal, and spray application in 1976 and 1979. Lessard and Holland (1985), using accumulation of degree-day data from *Bacillus thuringiensis* var. *kurstaki* field experiments near Los Alamos in 1974 and 1975, showed that egg hatch was complete and larval dispersal and development optimal at about 500 degree-days. Since Santa Clara Canyon is approximately 6 miles north of Los Alamos, 500 degree days was used as a guideline for establishing the earliest date the Santa Clara treatment could occur.

Virus Application Timing

On May 30, 2007, 535 degree-days had accumulated for the treatment site. The actual spray date was June 14, 2007 at which time over 1,291 degree-days had accumulated. Timing of treatment was delayed because of the short lead time for carrier procurement and shipping and because the Canyon was closed during the week of May 28, 2007 for Tribal ceremonies.

Pre-suppression Larval Sampling

Pre-suppression larval surveys (Appendix A) were conducted to establish population levels so that project effectiveness could be evaluated. Pre-suppression surveys were conducted the day before treatment was to begin (June 14, 2007). Caterpillars were mostly in the late second instar.

Aerial Application Specifics

The aerial application contractor was Aero Tech, based in Clovis, NM. Application was by fixed wing aircraft, model AT802 (Air Tractor Turbine) equipped with a SATLOC® differentially-corrected global positioning system (DGPS) guidance and navigation system. The pilot for the project was Ted Stallings. The full-service contract included personnel and equipment to handle all aircraft support activities including insecticide mixing, loading, and aircraft refueling. The operation was based at the Los Alamos County Airport. A pre-spray conference was held at the airport the day before the project started. The restricted airspace designation over the Los Alamos National Laboratory

limited the direction of approach and take-off and prevented on-site characterization of the spray aircraft. The aircraft arrived with a spray boom configuration of 38 flat fan nozzles with 8010 tips directed 45 degrees back and set to 40 psi. Calibration was checked by on-board automatic flow control monitoring equipment. The TM BIOCONTROL-1 virus, provided by the Forest Service, was received in cool, dry blocks which had to be re-hydrated in distilled water prior to mixing with the carrier. The material applied by the aircraft was made up of a total of 600 gallons of Omnova Carrier 038A plus enough water to mix the TM BIOCONTROL-1 virus into a slurry to facilitate mixing with the carrier. The 600 gallons of carrier/virus mixture were applied to 1160 acres at 0.5 gallon per acre in accordance with the labels (Appendix D). The entire spray operation, including loading, took 55 minutes. A post-spraying debriefing attended by all crew members was held at the airport after completion of air operations. Weather data are included in Appendix E**.**

Spray Deposition Monitoring

White Kromecote cards, placed in plastic card holders, were used to monitor spray deposition. In the morning, just prior to the spray application, twenty-four cards were place at twelve locations along the Canyon. Two sets of cards were also placed outside the treatment area on the east and west ends to monitor drift. The cards, two per location, were placed in clearings .2 to .4 miles apart along the Canyon.

Post-suppression Larval Population Densities

Post-suppression surveys were conducted 15 days (June 28, 2007) and 25 days (July 9, 2007) after treatment. DFTM larval population densities sampled 15 days after treatment (Appendix A, Table 3) remained relatively unchanged from pre-suppression densities (Appendix A, Table 2). Caterpillars sampled 15 days after treatment were a mix of mainly second and third instars. Most of these caterpillars were actively feeding and showed no signs of virus infection. A few dead, virus-killed tussock moth caterpillars, however, were observed hanging from the foliage of several host trees.

Larval densities 25 days after treatment were variable. Larval densities decreased slightly in the lower half of the treatment area, but increased in the upper portions of the Canyon (Table 4, Appendix A). Although there was a significant increase in the number of virus-killed caterpillars 25 days after treatment, there were still large numbers of tussock moth caterpillars actively feeding at all of the sites sampled. Because there is a five- to eight week incubation period after virus application before the larvae stop feeding, the virus may still have been incubating. Approximately 250-300 DFTM caterpillars were collected and sent to Imre Otvos of the Canadian Forest Service, Natural Resources, Pacific Forestry, B.C, Canada, to be analyzed for virus infection. All of the DFTM caterpillars tested were found to be infected with the TM-BIOCONTROL-1 virus.

Defoliation

Because viruses are slow acting and feeding is not inhibited until the larvae are close to pupation, there was no foliage protection achieved in Santa Clara Canyon during year of treatment. As the egg mass data collected in the spring of 2007 predicted (Table 1, Appendix A), defoliation was extremely heavy at several locations along the Canyon (Figures 1 and 2, below). Defoliation was heaviest along the lower half of the Canyon.

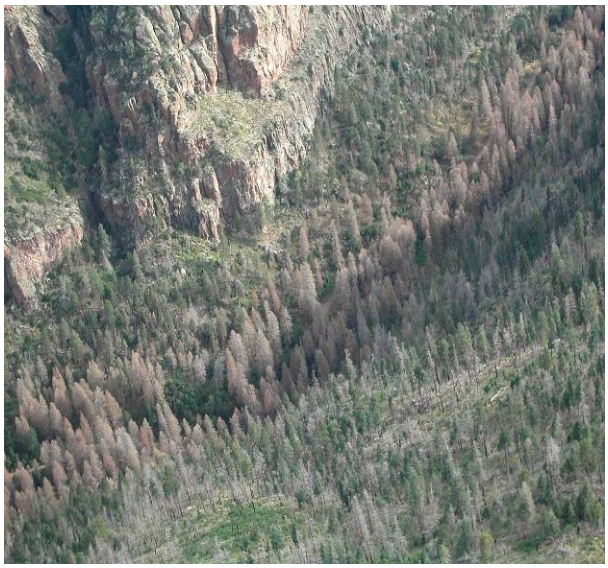

Figure 1. Aerial view of DFTM defoliation, Santa Clara Canyon 2007.

Figure 2. DFTM defoliation near fire station, Santa Clara Canyon, 2007.

Fall 2007 Egg Mass Survey

A fall sequential egg mass survey, using the procedures described in Appendix A, was conducted in the fall of 2007 to determine the status of the tussock moth in the Canyon (that is whether-or-not new egg masses were present). No new egg masses were collected during this survey. Since DFTM egg masses were very abundant in the in the spring indicating a releasing phase of the population was occurring, these results suggest the virus was successful in reversing that trend causing the population to collapse to low, undetectable levels

Summer 2008 Larval Survey

Because large numbers of DFTM caterpillars were actively feeding 25 days after treatment, and there were questions concerning project effectiveness, a follow-up DFTM larval survey was scheduled to be conducted in 2008. This survey was conducted on June 5, 2008, at which time the caterpillars would be actively feeding on the foliage. Larval population densities were sampled using the lower branch sampling method, described in Appendix A (Pre-suppression and Post-suppression Larval Sampling Procedures). A total 60 host trees were sampled (10 more than the year before) and the branches were not pruned, but held and beat over the sides of the sampling bag to minimized damage to host

trees. No DFTM caterpillars were detected at the sites sampled in the Canyon during this survey. These results confirmed that TM BIOCONTROL-1 successfully collapsed the tussock moth population to undetectable levels preventing a second year of heavy defoliation which would have resulted in a much greater level of host mortality than was experienced.

Although the project was successful in causing the premature collapse of the tussock moth population, notable host mortality occurred at several locations along the eastern half of the Canyon where trees were completely defoliated (Figures 3).

Figure 3. DFTM-caused mortality near old fire station, 2008

Tussock moth defoliation can be very damaging since it occurs too late in the season for trees to respond with latent bud development and refoliation. In areas where defoliation was less severe, the trees appear to be recovering.

Acknowledgements

Special thanks to Dick Reardon, Virus Application Specialist, USDA Forest Service; and to Bruce Bauer, Project Manager; Rachel Wood, Tribal Forester; Joey Gutierrez, Treatment Area Monitor; Walter Dasheno, Weather and Communications Officer; Jeff Lyon, Field Observer, GIS; Gary Honawa, Airport Communications; Cat Vigil, Treatment Area Monitor; Jeff Ham, Field Observer; Dave Lyon, Field Observer; and Mel Tafoya, SCP Office of Special Projects and Emergency Operations; of the Santa Clara Pueblo. Also, our appreciation is extended to John Anhold, Forest Health, Arizona Zone Leader, for on-site project assistance, to Stephani Sandoval, Cooperative Extension Service, New Mexico State University, for field support, and to all of the Santa Clara Pueblo Tribal members who assisted us with our larval, egg mass, and male moth monitoring. We would especially like to thank Imre Otvos, Canadian Forest Service, Natural Resources, Pacific Forestry, B.C, Canada, for conducting the DFTM bioassays.

Literature Cited

Lessard, Gene and David G. Holland. 1985. The use of degree-day accumulation for monitoring Douglas-fir tussock moth populations. Timber, Forest Pest, and Cooperative Forestry Management, USDA Forest Service, Rocky Mountain Region. Technical Report R2-31.

Ragenovich, Iral. 2004. 2003 Douglas-fir tussock moth early warning system trapping summary for Oregon and Washington. Forest Health Protection and Air Management Group/National Resources, Pacific Northwest Region USDA Forest Service. 2007.

.

Appendix A

Sequential Egg Mass Surveys

Monitoring of Egg Hatch and Timing of Application

Presuppression and Postsuppression Sampling Procedures

Sequential Egg Mass Surveys

Twenty DFTM host trees (Douglas-fir and white fir) were randomly selected for sampling. Each tree had to have at least three full-sized lower branches close enough to the ground so that the new egg masses could be easily seen. Egg masses were collected from three lower branches and the number per tree recorded cumulatively on a tally card until a total of 40 egg masses or greater was collected (Table 1).

Table 1. DFTM Sequential Egg Mass Survey Results, May 1, 2007

No. trees sampled	No. egg masses	Cum. No. egg masses
1	1	1
2	1	2
3	2	4
4	1	5
5	2	7
6	1	8
7	6	14
8	10	24
9	9	33
10	3	36
11	5	41
12	3	44
13	0	44
14	4	48
15	0	48
16	0	48
17	4	52
18	2	54
19	3	57
20	0	57

$$\frac{\text{Total No. of Egg Masses}}{\text{No. of Trees}} = \frac{57}{20} = 2.9 \text{ (see prediction level below)}$$

	Avg. no. of Egg Masses per 3 Branches	Predicted Level of Defoliation
	Less than 0.7	Light or no defoliaton the following year
	Between 0.7 and 1.9	Moderate but variable defoliation predicted
2.9 →	More than 2.0	Expect severe defoliation, some top-kill and some mortality

Monitoring of Egg Hatch and Timing of Application

Lessard and Holland (1985) determined that in Los Alamos, New Mexico, DFTM egg hatch usually occurs near 220 degree-days and that dispersal and larval development were optimal at 500 degree-days from the first day of May. Degree-days were calculated as follows:

$$\frac{\text{Max Daily Degree} + \text{Min Daily Degree}}{2} - 42 \text{ Degrees F}$$

The threshold temperature for egg hatch for the Douglas-fir tussock moth is 42 degrees F. All plus degree-days values are accumulated. Negative values are treated as zero values and do not enter into the calculation.

The maximum and minimum temperatures for Los Alamos, NM were obtained from the Albuquerque Journal the day after they occurred.

Presuppression and Postsuppression Sampling Procedures

Fifty host trees were sampled within the treatment area. Five trees were sample at ten plots spaced .2 to .4 miles apart along the roadside of Santa Clara Canyon. Douglas-fir and white fir were sampled without preference. The only criterion for tree selection was that they have foliage on low branches that could be reached from the ground. Three 18 inch branch tips were sampled on each tree. Each branch was clipped with a hand pruner and beat around a pole pruner collecting bag to dislodge all the DFTM larvae. Each branch was closely examined and any larvae still on the branch counted. The total larval count from the three branches samples was a sample.

Presuppression larval surveys were conducted on June 13, 2007. Postsuppression surveys were conducted on June 28, 2007 (15 days after treatment) and on July 9, 2007 (25 days after treatment).

Table 2. Presuppression DFTM Larval Densities, June 13, 2007

Plot no.	Tree no.	No./3 branches	Plot no.	Tree no.	No./ 3 branches
1	1	7	6	1	17
	2	8		2	7
	3	8		3	7
	4	10		4	26
	5	11		5	16
2	1	25	7	1	3
	2	53		2	7
	3	72		3	1
	4	54		4	3
	5	91		5	2
3	1	22	8	1	2
	2	25		2	0
	3	20		3	2
	4	33		4	0
	5	36		5	0
4	1	142	9	1	1
	2	89		2	2
	3	79		3	1
	4	43		4	0
	5	73		5	1
5	1	17	10	1	0
	2	15		2	0
	3	10		3	0
	4	18		4	0
	5	31		5	0

Table 3. Day 15 Postsuppression DFTM Larval Densities, June 28, 2007

Plot no.	Tree no	No./3 branches	Plot no.	Tree no.	No./3 branches
1	1	16	6	1	22
	2	3		2	22
	3	13		3	1
	4	23		4	2
	5	4		5	1
2	1	29	7	1	0
	2	25		2	2
	3	53		3	0
	4	16		4	1
	5	24		5	1
3	1	57	8	1	0
	2	12		2	0
	3	36		3	0
	4	4		4	0
	5	8		5	0
4	1	5	9	1	0
	2	33		2	0
	3	50		3	0
	4	44		4	1
	5	22		5	0
5	1	22	10	1	3
	2	33		2	2
	3	34		3	12
	4	39		4	4
	5	4		5	0

Table 4. Day 25 Postsuppression DFTM Larval Densities, July 9, 2007

Plot no.	Tree no.	No./3 branches	Plot no.	Tree no.	No./3 brnches
1	1	7	6	1	8
	2	3		2	1
	3	6		3	7
	4	1		4	6
	5	1		5	2
2	1	0	7	1	7
	2	1		2	24
	3	24		3	7
	4	32		4	7
	5	10		5	6
3	1	6	8	1	23
	2	21		2	12
	3	9		3	2
	4	3		4	13
	5	5		5	20
4	1	12	9	1	14
	2	6		2	3
	3	10		3	0
	4	21		4	8
	5	13		5	1
5	1	15	10	1	1
	2	20		2	8
	3	8		3	4
	4	15		4	18
	5	20		5	8

Appendix B

May 9, 2007 Biological Evaluation Letter to Bruce Bauer

United States Department of Agriculture
Forest Service
R3 Regional Office
333 Broadway SE
Albuquerque, NM 87102
FAX (505) 842-3800
V/TTY (505) 842-3292

File Code: 3420
Date: May 9, 2007

Bruce Bauer
Forestry Director
Santa Clara Pueblo, Forestry
PO Box 580
Espanola, NM 87532

Bruce:

This letter documents the results of the ground examination we conducted on May 1, 2007 with Frank Lafferty, Forest Crew Member. The purpose of this examination was to determine the current status of the Douglas-fir tussock moth (DFTM) in Santa Clara Canyon. As you recall, this ground examination was initiated because of the DFTM egg masses Dave Conklin, Forest Pathologist of our staff, found while assisting you putting out MCH bubble caps to protect the Douglas-fir trees from Douglas-fir beetle attacks. The egg masses he brought back to the office were very robust. Most if not all the eggs hatched two weeks later after being kept at room temperature. Following is a brief summary of the results of our ground examination:

Although no DFTM defoliation was detected in 2006 (refer to our 3410 letter dated December 12, 2006) our ground examination revealed both light defoliation and an abundance of DFTM egg masses (Figure 1) and pupal cases (Figure 2) on the Douglas-firs and white firs, the preferred hosts of the DFTM.

Figure 1. DFTM egg masses and cocoons on white fir, Santa Clara Canyon, 2007

The egg masses and pupal cases were also abundant on the walls and eves of the structures examined at the fire station site (Figures 2 and 3).

Figures 2 and 3. DFTM pupal cases on the walls and under the eves at the Fire Stations site

Because of the numerous egg masses observed on the mixed conifer in Santa Clara Canyon we believe the tussock moth will increase to outbreak levels causing moderate to heavy defoliation in parts of Santa Clara Canyon over the summer. This pending outbreak appears to be similar to the 1976 outbreak that occurred on forested land in Los Alamos and Pueblo Canyons, which dissect the town site area of Los Alamos. Defoliation was light in 1976 and numerous egg masses were found on the above mentioned forested lands. By 1977, moderate to complete defoliation occurred on 600 acres of mixed conifer type in these canyons.

DFTM outbreaks have a pattern that can be separated in to four phases: a release phase in which tussock moth populations rapidly increase to outbreak numbers; a peak phase when insect densities reach their maximum; a decline phase when populations begin a rapid decrease; and a post decline phase when populations reach their lowest level. Each phase generally lasts a year and is defined by population level, defoliation intensity, and within generation survival rates. Based on the numbers of egg mass observed, the tussock moth in Santa Clara Canyon appears to be either at or nearing the release phase of the outbreak cycle described above. The best time to initiate treatment strategies for

DFTM is prior to the occurrence of significant defoliation as in the case in Santa Clara Canyon. After the first year of moderate to heavy defoliation, large scale treatments may not be an option due to the advanced stage of the outbreak.

Because the proposed treatment area is along Santa Clara Creek and the ponds, treatment options are likely limited to microbial controls such as TM-Biocontrol and B.t.k. TM-Biocontrol is a nucleopolyhedrosis virus (NPV). The NPV used in TM-Biocontrol occurs naturally in the soil in areas affected by tussock moth outbreaks. NPV is highly specific to tussock moths. B.t.k. on the other hand, is an aerobic spore forming bacterium that produces a diamond shaped proteinaceous crystalline inclusion that damages the midgut cells of tussock moths after ingestion. Once ingested, B.t.k. causes almost immediate cessation of feeding. B.t.k., unlike TM-Biocontrol, affects the larvae of many species of moths and butterflies.

The DFTM has one generation per year. The insect overwinters in egg masses that contain 150-250 eggs. Egg masses are commonly found on the undersides of small branches. Egg masses are distributed throughout the foliar crown, but are concentrated in the upper crown, and may be found on the trunk, nearby structures, and other vegetation, etc.

Eggs hatch in late spring, and leave the egg mass when shoot elongation is about 50% completed. Larval feeding occurs when it is too late in the season for a tree to respond with latent bud development, so when significant defoliation occurs, the tree cannot initiate new buds to replace the lost foliage next spring. Small larvae produce silk strands for wind dispersal through the forest. First and second instar larvae feed exclusively on the undersides of the soft, new foliage. This feeding kills the foliage, which turns red, but may persist on the tree throughout the summer giving affected areas a reddish cast. When at high densities, new foliage may be consumed in 2-3 weeks forcing the larvae to feed on the older foliage. Later instar larvae can completely strip all needles from trees if larval densities are extremely high.

Larval feeding lasts approximately 60 days (June and July), and then pupation occurs (late July through August). Larvae spin cocoons in the foliated portions of the crown, in bark crevices, and on twigs in the lower crown. Moths emerge approximately 2 weeks after pupating. The female moth is wingless and stays on her cocoon where she emits a pheromone attracting male moths. Having mated, the female lays her eggs, completing the yearly cycle.

Many natural agents exist that keep tussock moth populations at low levels most of the time. These include small wasps that parasitize the eggs and pupae, flies that parasitize the larval stage, and birds and other predators that destroy large numbers of larvae, pupae, and egg masses. In a recent outbreak in the Sandia Mountains, a naturally occurring virus did contribute to the population collapse; however, considerable tree mortality occurred before caterpillar populations succumbed.

If you have any questions concerning this evaluation or need additional information, please call me at 505.842.3287 or e-mail me at trogers@fs.fed.us.

Sincerely,

/s/ Terrence J. Rogers
TERRENCE J. ROGERS
Entomologist, Forest Health, New Mexico Zone

Cameron Martinez, Superintendent, Northern Pueblos Agency, PO Box 4269, Fairview Station, Espanola, NM 87533, John Waconda, Regional Forester, Bureau of Indian Affairs, PO Box 26567, Albuquerque, NM 87125, Gilbert Zepeda, Director Forestry/Forest Health/Cooperative International Forestry, Debra Allen Reid, Forest Health Zone Leader, New Mexico Zone, John Anhold, Forest Health Zone Leader, Arizona Zone

Appendix C

Agreement Between the Forest Service and the Santa Clara Pueblo

FS Agreement No 07-PA-11031600-120
Cooperator Tax ID No.
Cooperator DUNS No.
Cooperator Agreement No.
7/31/08

PARTICIPATING AGREEMENT
between
USDA, FOREST SERVICE, SOUTHWESTERN REGION
and
SANTA CLARA PUEBLO

This PARTICIPATING AGREEMENT is hereby entered into by and between the USDA Forest Service, Southwestern Region, hereinafter referred to as the "Forest Service" and the Santa Clara Pueblo, hereinafter referred to as the "Tribe" or "recipient" or "cooperator" under the authority of the Tribal Forest Protection Act of 2004 (Public Law 108-278; 25 USC 3101 et seq.; 25 USC 3115a).

A. PURPOSE:

The purpose of this agreement is to protect forest lands held in trust for the Tribe by the United States from the adverse effects of the Douglas-fir tussock moth. Specifically, the Forest Service will convey to the Tribe sufficient TM-Biocontrol (a concentrated form of a natural tussock moth virus which kills only tussock moth species) to treat up to 1200 acres of Tribal forest land, and will provide technical assistance to ensure the material is applied effectively. The virus will be applied during the month of June on a mutually agreed upon date.

B. STATEMENT OF MUTUAL BENEFIT AND INTERESTS:

The Douglas-fir tussock moth outbreak poses a threat to Tribal community, cultural and natural resource values. Since ecosystems transcend land ownership boundaries, effective land and resource management requires cooperation and collaboration among the Forest Service and Tribal governments. The Tribal lands to be treated are adjacent to the Santa Fe National Forest.

C. THE FOREST SERVICE SHALL:

1. Provide to the Tribe 1200 acre-equivalents of the TM-Biocontrol virus, a perishable living organism which will be expended through aerial application to the forest. Any unused TM-Biocontrol product will be returned to the Forest Service.
2. Provide technical assistance for proper handling and application of TM-Biocontrol to the designated treatment area.

D. THE TRIBE SHALL:

1. Procure a sufficient quantity of carrier material (the liquid base into which the TM-Biocontrol spores will be mixed) needed for aerial application to 1200 acres.
2. Engage a full-service aerial applicator to provide all aircraft support and application needs and assume the cost for the contract.
3. Provide labor needed to fill project roles not covered by Forest Service technical assistance providers.

E. IT IS MUTUALLY UNDERSTOOD AND AGREED BY AND BETWEEN THE PARTIES THAT:

1. NO FUNDS WILL BE TRANSFERRED UNDER THIS AGREEMENT.

2. TAXPAYER IDENTIFICATION NUMBER. The cooperator shall furnish their tax identification number upon execution of this instrument.

3. FREEDOM OF INFORMATION ACT (FOIA). Any information furnished to the Forest Service under this instrument is subject to the Freedom of Information Act (5 U.S.C. 552).

4. RETENTION AND ACCESS REQUIREMENTS FOR RECORDS. The Forest Service, Inspector General, or Comptroller General, through any authorized representative, shall have access to and the right to examine all records related to this instrument. As used in this provision, "records" includes books, documents, accounting procedures and practices, and other data regardless of type and regardless of whether such items are in written form, in the form of computer data, or in any other form. All records pertinent to this agreement shall be retained for a period of 3 years.

5. MODIFICATION. Modifications within the scope of the instrument shall be made by mutual consent of the parties, by the issuance of a written modification, signed and dated by all parties, prior to any changes being performed. The Forest Service is not obligated to fund any changes not properly approved in advance.

6. NONDISCRIMINATION. The recipient/cooperator shall comply with all Federal statutes relating to nondiscrimination and all applicable requirements of all other Federal laws, Executive orders, regulations, and policies, subject to its right to engage in Indian preference in employment. These include but are not limited to: (a) Title VI of the Civil Rights Act of 1964 (42 U.S.C. 2000d, 2000e-16), which prohibits discrimination on the basis of race, color, disability, or national origin; (b) Title IX of the Education amendments of 1972, as amended (20 U.S.C. 1681-1683, and 1685-1686), which prohibits discrimination on the basis of sex; and Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) which prohibits discrimination on the basis of disabilities. The nondiscrimination statement which follows shall be posted in primary and secondary recipient/cooperator offices, at the public service delivery contact point and included, in full, on all materials regarding such recipients'/cooperators' programs that are produced by the recipients/cooperators for public information, public education, or public distribution:

> ***"In accordance with Federal law and U.S. Department of Agriculture policy, this institution is prohibited from discriminating on the basis of race, color, national origin, sex, age, or disability. (Not all prohibited bases apply to all programs.)***
>
> To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, Room 326-W, Whitten Building, 1400 Independence Avenue, SW, Washington, DC 20250-9410 or call (202) 720-5964 (voice and TDD). USDA is an equal opportunity provider and employer."

If the material is too small to permit the full statement to be included, the material will at minimum include the statement, in print size no smaller than the text, that ***"This institution is an equal opportunity provider."***

7. LEGAL AUTHORITY. The cooperator has the legal authority to enter into this instrument, and the institutional, managerial and financial capability (including funds sufficient to pay nonfederal share of project costs) to ensure proper planning, management, and completion of the project.

8. PARTICIPATION IN SIMILAR ACTIVITIES. This instrument in no way restricts the Forest Service or the Cooperator(s) from participating in similar activities with other public or private agencies, organizations, and individuals.

9. EXTENSION OF PERFORMANCE PERIOD. The Forest Service, by written modification may extend the performance period of this instrument for a total duration not to exceed 5 years from its original date of execution.

10. TERMINATION. Any of the parties, in writing, may terminate the instrument in whole, or in part, at any time before the date of expiration.

11. PRINCIPAL CONTACTS. The principal contacts for this instrument are:

Forest Service Project Contact	***Cooperator Project Contact***
Debra Allen-Reid	Bruce Bauer
USDA Forest Service, R3 FFH	Forestry Director
333 Broadway Blvd., SE	Santa Clara Pueblo
	P.O. Box 580
Albuquerque, NM 87102	Espanola, NM 87532
Phone:505-771-0744	Phone:505-753-7326 ext. 298
FAX:505-842-3150	FAX:
E-Mail:dallenreid@fs.fed.us	E-Mail:bbauer@santaclarapueblo.org
Forest Service Administrative Contact	***Cooperator Administrative Contact***
Susan Mc Donnell	*Same as Project Contact*
Grants and Agreements Specialist	
333 Broadway Blvd SE	
Albuquerque, NM 87120	
Phone: 505 842-3345	Phone:
FAX: 505 842-3111	FAX:
E-Mail: smcdonnell@fs.fed.us	E-Mail:

12. ALTERNATE DISPUTE RESOLUTION. In the event of any issue of controversy under this Agreement, the parties may pursue Alternate Dispute Resolution procedures to voluntarily resolve those issues. These procedures may include, but are not limited to, conciliation, facilitation, mediation, and fact finding.

FS Agreement No 07-PA-11031600-120
Cooperator Tax ID No.
Cooperator DUNS No.
Cooperator Agreement No.
7/31/08

13. COMMENCEMENT/EXPIRATION DATE. This instrument is executed as of the date of last signature and is effective through July 31, 2007, at which time it will expire unless extended.

14. FOREST SERVICE LIABILITY. The Forest Service shall not be liable to the depositor or landowner for any damage incident to the performance of this agreement.

15. AUTHORIZED REPRESENTATIVES. By signature below, the cooperator certifies that the individuals listed in this document as representatives of the cooperator are authorized to act in their respective areas for matters related to this agreement.

IN WITNESS WHEREOF, the parties hereto have executed this agreement as of the last written date below.

/s/*Lucia M. Turner*
LUCIA M. TURNER
Deputy Regional Forester

USDA FOREST SERVICE
Date
_06/07/2007_

/s/*J. Micahel Chavarria*
J. MICHAEL CHAVARRIA
Governor

SANTA CLARA PUEBLO
Date
_06/07/2007_

The authority and format of this instrument has been reviewed and approved for signature.
/s/Susan K. McConnell 6/7/2007

DATE
FS Grants & Agreements Specialist

Appendix D

Product Labels

CARRIER 038A

AQUEOUS FLOWABLE CARRIER FOR GYPCHEK OR TM-BIOCONTROL-1 NPV

KEEP OUT OF REACH OF CHILDREN

CAUTION

INGREDIENTS:
Proprietary materials, water 100%

PRACTICAL TREATMENT:
Avoid contact with skin, eyes or clothing. In case of contact, immediately flush eyes or skin with plenty of water. Get medical attention if irritation persists. Inhalation may induce asthmatic attack in individuals sensitive to sulfites. If inhaled, remove from exposure.

PRINCIPAL USE:
CARRIER 038 and 038A are aqueous flowable, concentrated suspensions of EPA approved inert ingredients. They are specifically formulated to be used with GYPCHEK (EPA-27586-2) and TM-BIOCONTROL-1 (EPA-27586-1) to improve the deposit of, and provide protection to, the active ingredient of the GYPCHEK and TM-BIOCONTROL-1 NPV. CARRIER 038 contains powdered lignosulfonate, and CARRIER 038A contains liquid lignosulfonate. CARRIER 038A is less prone to clumping and should be used rather than CARRIER 038.

STORAGE AND DISPOSAL:
Do not contaminate water, food or feed by storage or disposal of waste.

Storage: Tightly reclose containers of unused CARRIER and store in upright position. Do not allow freezing.

Disposal: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility in accordance with federal and local regulations.

Container Disposal: Triple rinse (or equivalent). Then offer for recycling or reconditioning or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities.

Manufactured For:

U.S. Department of Agriculture
Forest Service
180 Canfield Street
Morgantown, WV 26505

DIRECTIONS FOR USE:
Mixing: Make a slurry of the GYPCHEK or TM-BIOCONTROL-1 NPV (see the GYPCHEK or TM-BIOCONTROL-1 labels for recommended dose rates). Place the GYPCHEK or TM-BIOCONTROL-1 slurry into the mix tank of 038A. Slowly add the GYPCHEK or TM-BIOCONTROL-1 slurry to the mix tank. Agitate/recirculate while adding the GYPCHEK or TM-BIOCONTROL-1 to assure homogeneity of the final tank mix suspension.

Air Application: Use the recommended amount of GYPCHEK or TM-BIOCONTROL-1 (see GYPCHEK or TM-BIOCONTROL-1 label) in 0.5-2 gallon of CARRIER 038A tank mix per acre.

WARRANTY NOTICE:
VALENT BIOSCIENCES CORP. MAKES NO WARRANTY OF MERCHANT ABILITY, FITNESS FOR ANY PURPOSE, OR OTHERWISE, EXPRESS OR IMPLIED, concerning this product or its uses which extend beyond the use of the product under normal conditions in accord with the statements made on this label. In no case shall the seller be liable to consequential, special, or indirect damages resulting from the use or handling of this product. All such risks shall be assumed by the buyer.

Lot No.: _____

Net Contents:

For Douglas-fir Tussock Moth

Orgyia pseudotsugata

TM Biocontrol-1

Biological Insecticide

Wettable Powder

ACTIVE INGREDIENT:*

Douglas-fir tussock moth nucleopolyhedrovirus 14.6%

INERT INGREDIENTS:

Insect parts/inert solids 85.4%

Total 100.0%

* (equivalent to at least 1.28×10^{10} OB/gm)

There is no direct relationship between intended activity (potency) and the percent active ingredient by weight.

KEEP OUT OF REACH OF CHILDREN

WARNING
AVISO

Read First Aid Treatment Before Use

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

USDA Forest Service
180 Canfield Street
Morgantown, WV 26505

EPA Registration No. 27586-1
EPA Establishment No. 58971-MD-001

Net Weight: _____ oz. Lot No. _____

ACCEPTED
FEB 2 5 2005
Under the Federal Insecticide, Fungicide, and Rodenticide Act, as amended, for the pesticide registered under EPA Reg. No. 27586-1

FIRST AID

If on skin or clothing	• Take off contaminated clothing • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatement advice.
If in eyes	• Hold eyelid open and rinse slowly and gently with wate for 15-20 minutes. • Remove contact lenses, if present, after the first 5 min tes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.

HOT LINE NUMBER

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-222-1222 (24 Hours) for emergency medical treatment. For other information, call 1-800-858-7378.

PRECAUTIONARY STATEMENTS

Hazards to Humans & Domestic Animals

WARNING

Causes moderate, but temporary eye irritation. Avoid contact with eyes, skin, open wounds, or clothing. Wash thoroughly with soap and water after handling. Remove contaminated clothing and wash before reuse. Prolonged or repeated skin contact may cause allergic reactions in some individuals.

Personal Protective Equipment (PPE)

Mixers and other handlers must wear:

- Long-sleeved shirt and long pants
- Shoes plus socks
- Waterproof gloves
- Mixers/loaders and applicators not using enclosed cabs or aircraft must also use:
- Additional protective eyewear (goggles or face shield)
- Dust/mist filtering respirator meeting NIOSH stardards of at least N-95, R-95, or P-95.

After product is diluted in accordance with the directions for use, protective eyewear and respirators are not required. Follow manufacturer's instructions for cleaning and maintaining PPE. If no such instructions

for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

User Safety Recommendations

Users Should:

- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet
- Remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

Environmental Hazards

Do not contaminate water when cleaning equipment or disposing of equipment washwaters.

DIRECTIONS FOR USE

It is a violation of federal law to use this product in a manner inconsistent with its labeling.

Only for formulation into a biological insecticide for use in managing Douglas-fir tussock moth infestations in wide-area public pest control programs sponsored by government entities.
Application of this product is limited to forest trees and ornamental or non-commercial trees in urban parks, golf courses, lawns and landscapes. Tree species include but are not limited to Douglas-fir, grand fir, white fir, red fir, subalpine fir, blue spruce and Englemann spruce.

TM Biocontrol-1 contains a virus that is toxic to larvae of the Douglas-fir tussock moth, *Orgyia pseudotsugata*. Maximum efficacy is achieved when a lethal dose of the viral agent is consumed by early instar larvae. TM Biocontrol-1 should be applied soon after egg hatch, when first and second instar larvae are actively feeding, and new needles are expanding (May to mid-July). Best results are expected when applications are made early in the morning on dry foliage. Rainy weather may necessitate repeated applications. Spray appplication is not recommended if rain is predicted within 12 hours.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. Keep unprotected persons out of the treated areas until sprays have dried. Do not apply this product through any type of irrigation system. Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment and weather-related factors determine the potential for spray drift. The applicator and the treatment coordinator are responsible for considering all of these factors when making decisions.

This product is sensitive to environmnetal conditions and should be stored in a cool dark place prior to use (read STORAGE AND DISPOSAL section).

Mixing Instructions

Add TM Biocontrol-1 to recommended carrier in the proper ratio for per acre dosages and agitate to maintain suspension. Consult USDA Forest Service for currently recommended carriers in tank mix.
Never use chlorinated water in the spray formulation. If pH is < 6.0 or > 7.2, add appropriate amount of acid to adjust to within acceptable pH range.

Spray Volumes

- **Ground application:** It is recommended that up to 0.4 oz (1.4×10^{11} OB) of TM Biocontrol-1 per acre be applied one or more times with a high volume hydraulic sprayer at a rate of 100 gallons per acre of tank mix to woodlots and small acreages. Individual large trees should be sprayed once to provide through coverage. If needed, a second spray may be applied within 5 days.

- **Aerial Application:** Current recommended dosage of one application up to 0.2 oz (7.0×10^{10} OB) of TM Biocontrol-1 per acre. For tank mix volumes, use ½ to 2 gallons per acre. If needed, a second spray may be applied within 5 days.

STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal of waste.

Storage: Direct sunlight or temperatures above 80^0 F will impair activity. Store in sealed containers in cool dry place. Temperatures below freezing are recommended for long term storage.

Pesticide Disposal: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility in accordance with federal and local regulations.

Container Disposal: Completely empty bag into application equipment. Then dispose of empty bag in a sanitary landfill or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

NOTICE

The USDA Forest Service makes no warranty, express or implied, of merchantability and/or fitness concerning this material, except those contained on the label. **For additional information and assistance contact USDA Forest Service, Pacific Northwest Region, La Grand, OR, (541) 962-6545.**

TM BIOCONTROL-1
BIOLOGICAL INSECTICIDE
FOR THE
DOUGLAS-FIR TUSSOCK MOTH

Active Ingredient:*
Polyhedral inclusion bodies of Douglas-fir tussock moth nucleopolyhedrosis virus.....3.5%
Inert ingredients:.....96.5%
TOTAL.....100.0%

* Contains at least 2 billion activity units per gram.

KEEP OUT OF THE REACH OF CHILDREN
CAUTION
See other panel for additional precautionary statements

For use by or under the supervision of the U.S. Forest Service.

NOTICE: The U.S. Forest Service makes no warranty, express or implied including the warranties of merchantability and/or fitness for any particular purpose, concerning this material except those which are contained on the U.S. Forest Service's label.

EPA REG. NO. 27586-1

Processed and Packaged for The USDA Forest Service,
BY: Espro, Inc.
8980 Oakland Ctr.
Route 108
Columbia, MD 21045

EPA EST. NO. 58971-MD-001

NET WEIGHT: 47 Grams LOT NO. 8901

DIRECTIONS FOR USE
GENERAL CLASSIFICATION

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

For population reduction of the Douglas-fir tussock moth, apply by air at the rate of one package (47g.) TM Biocontrol-1 in 100 to 200 gallons finished spray per 100 acres. Stickers and u.v. protectants may enhance performance of this product. Refer to technical bulletin for mixing and application instructions. Spray tank mixture pH should be 6.0 to 7.2 **NEVER USE CHLORINATED WATER IN THE SPRAY FORMULATION.**

PRECAUTIONARY STATEMENTS
CAUTION
ENVIRONMENTAL HAZARDS

Avoid application to lakes, streams, or ponds. Do not contaminate water by cleaning of equipment or disposal of wastes.

STORAGE AND DISPOSAL

Activity may be impaired by storage above 80° F

Do not contaminate water, food, or feed by storage or disposal. Open dumping is prohibited. Do not reuse empty container.

Pesticide, spray mixture, or rinsate that cannot be used should be disposed of in a landfill approved for pesticides or buried in a safe place away from the water.

Container disposal: Triple rinse and dispose of in an approved landfill or bury in a safe place.

Consult Federal, State, or local disposal authorities for approved alternative procedures.

[redacted] container
46 acre dose
Contents: TM Biocontrol – 1
USFS Lot No. 6
1.03 grams per acre-dose

Appendix E

Project Application Times and Weather Data

Weather and Application Times

Date of Application: June 14, 2007

Time of take off:	0600
Return Landing:	0700
Second take off:	0721
First Spray Pass:	0725
Completed All Passes:	0755
Final Landing:	0802

Weather Reading 1

Time:	0540
Location:	On ridge near repeater
Wind:	0-8 West
Dry Bulb Reading:	50
Wet Bulb Reading:	43
Relative Humidity:	60%

Weather Reading 2

Time:	0550
Location:	In Canyon near third pond
Wind:	W/NW
Relative Humidity:	95%
Cloud Cover:	0%

Weather Reading 3

Time:	0710
Location:	Ridgetop repeater
Wind:	0-1 West
Dry Bulb Reading:	55
Wet Bulb Reading:	45
Relative Humidity:	49
Cloud Cover:	0%

Observers reported good settling of material into canopy throughout application

0% precipitation for 24 hours after application

Appendix F

Project Contract List and Roles

2007 Douglas-fir Tussock Moth Project Coordination Contact List

(from the 2007 Santa Clara Pueblo Douglas-fir Tussock Moth
Aerial Suppression Project Operations and Safety Plan**)**

Forest Service Personnel	Phone Number
USDA Forest Service, NM Zone Forest Health, Regional Office Deb Allen-Reid, Project Advisor/Pueblo-Forest Service Liaison USDA Forest Service, Region 3 333 Broadway Blvd., SE Albuquerque, NM 87102	Desk: (505) 842-3286 Cell: (505) 301-1271
USDA Forest Service, NM Zone Forest Health, Regional Office Terry Rogers, Project Entomologist/Treatment Monitor USDA Forest Service, Region 3 333 Broadway Blvd., SE Albuquerque, NM 87102	Desk:(505) 842-3286 Cell: (505) 301-1272
USDA Forest Service, Forest Health Technology Enterprise Team Dick Reardon-Virus Application Specialist 180 Canfield Street Morgantown, WV	Desk: (304) 285-1566 Cell: (304) 282-8373
USDA Forest Service, Pesticide Specialist, Regional Office Allen White – Load Checker/Assistant to Virus Application Specialist USDA Forest Service, Region 3 333 Broadway Blvd., SE Albuquerque, NM 87102	Desk: (505) 842-3280
Aerial Applicator	**Phone**
Ted Stallings, Aero Tech, Inc. - Pilot 5333 East 21st Street Clovis, NM 88101	Desk: (505) 763-4300 Cell: (303) 619-9347 Motel: 622-2441
Project Operations Contacts	**Phone**
Bruce Bauer, SCP Forestry Director-Project Manager Santa Clara Pueblo P.O. Box 580 Espanola, NM 87532	Desk:(505) 753-7326 x 298 Cell: (505) 795-2066
Rachel Wood, Tribal Forester Santa Clara Pueblo P.O. Box 580 Espanola, NM 87532	(505) 752-7326 x304 (505) 929-8062-cell
Santa Fe Zone Dispatch-Terry or Renee Dispatch Frequencies: Transmit-172.300, Receive-171.550 Tone Guard for transmit and receive-103.5	(505) 438-7800
Pilot Frequencies (for ground to air communications)	152.745 152.915

Mel Tafoya SCP Office of Special Projects and Emergency Operations P.O. Box 580 Espanola, NM 87532	929-0729-cell
Los Alamos Airport David Plewger and Georgia **Gate Code 1812 star(*)**	(505) 412-9869
Santa Clara Pueblo Government Officials	**Phone**
Governor J. Michael Chavarria Santa Clara Pueblo P.O. Box 580 Espanola, NM 87532	753-7326 ext. 201
Lt. Governor Alvin Warren Santa Clara Pueblo P.O. Box 580 Espanola, NM 87532	753-7326 ext. 206
Material Transport and Manufacturer	**Phone**
Yellow Freight Theresa 203-288-897	1-800-610-6500 x 2816 Fax: 913-982-1743
Omnova	1-888-253-5454
SCP Forestry Crew Project Leaders	**Phone**
Joey Gutierrez: Treatment Area Monitor	929-4132
Walter Dasheno: Weather, Communications Officer	929-4239
Jeff Lyon: Field Observer, GIS	927-4667
Gary Honawa: Airport Communications	692-9349
Cat Vigil: Treatment Area Monitor	570-9919
Jeff Ham: Field Observer	699-4301
Dave Lyon: Field Observer	929-3093

PROJECT ROLES

Project Director: Bruce Bauer
Weather Monitor/Recorder: Bruce Bauer and Walter Dasheno. Will report forecast for the spray day, monitor current weather conditions (wind speed, relative humidity, etc.) and report observations for pilot.
Communications and Safety Officer: Walter Dasheno. Will coordinate communications between pilot and ground; will assure equipment is in place and radio frequencies are aligned between pilot and ground.
Airport Communications Officer: Gary Honawa. Will be in communication with pilot and all ground personnel.

Field Observers: Jeff Lyon, Bruce Bauer, Rachel Wood, Jeff Ham. Will observe the deposition of the material and report in during the operations. These observations are critical in case a rogue wind blows the material off target or a warming of the ground prevents the droplets from being properly deposited on the foliage. Field observers should report to the Project Director and if unreachable, the Airport Communications Officer.

Treatment Area Monitoring: Terry Rogers, Cat Vigil, Joey Gutierrez. Will assist project entomologist in pre- and post- treatment sampling of insects, placing field deposition cards to assure coverage and observing air operations in the field.

Project Entomologist/Treatment Monitor: Terry Rogers (USFS) will fill this role which includes pre- and post- treatment sampling of insects, placing field deposition cards to assure coverage, and observing air operations in the field.

Virus Application Specialist: Dick Reardon (USFS) will fill this role which characterizes and calibrates aircraft; oversees handling and mixing of virus with carrier; troubleshoots problems related to material handling; liaison with pilot regarding technical matters pertaining to mixing or application of the material.

Load Checker: Allen White (USFS) will fill this role which will assist Virus Application Specialist with the virus and carrier; will assure the proper number of loads are applied to the treatment area.